FY96 End of Fiscal Year Letter
(01 Oct 1995 - 30 Sep 1996)

ONR CONTRACT INFORMATION

Contract Title: Investigation into the Susceptibility of Corrosion Resistant Alloys to Biocorrosion

Performing Organization: State University of New York at Stony Brook

Principal Investigator (include telephone, fax, and e-mail address):

Clive. R. Clayton (Tel: 516-632-9272, Fax: 516-632-8205)
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Contract or Grant Number: N000149610059

R & T Project Number:

ONR Program Officer: Dr. A. J. Sedriks

Research Goals

A. The goal of this scientific research is to determine the mechanisms by which Sulphate Reducing Bacteria through formation of biofilms and emission of metabolic products modify the ability of engineering alloys to resist corrosion by passivation.

Significant Results in the Past Year

B. The conclusion of this program established the following:

a) A rapid experimental procedure has been developed for determining the susceptibility of engineering alloys (stainless steels) to surface modification by exposure to SRB and their metabolic products, and the impact of that surface modification on the intrinsic ability of the alloy to develop and maintain, a passive film.

b) It was shown that Mo addition to stainless steels has mixed effects on MIC.

1) Molybdate, which is found in the outer regions of the passive films of stainless steel, is susceptible to reduction to the pentavalent-state following reduction by extracellular proteins containing disulfide functional groups. This appears to bind extracellular protein to the oxide film and presumably enables the protein to act as a conditioning film for further biofilm accumulation.

2) Mo also is seen to prevent ingress of H_2S to the passive film-metal interface and prevents interfacial sulphide formation which in turn causes passive film disruption and pitting.

3) SRB were found to attack Fe and stainless steel forming black corrosive products in the growth media, only if the surface is lightly oxidized say by vacuum annealing.

4) In the course of these studies SRB was found to react with Si, Fe, Cr, Ni, Mo, 304 and 317 ss (to lesser extent) and AL6X and AL6XN was seen to be attacked in the supernatant of SRB growth media following 5 days in the growth media.

C. Plans for Next Years Research

The program is officially terminated. However, we intend to publish at least 4 pages resulting from the pioneering stage of this work. Many new research avenues, slowly evolved from this difficult program, which are to be followed up, if funding is available.

D. List of Publications/Reports/Presentations

1. Papers Published in Refereed Journals

A study of Molybdate and Chromate Interactions with the Exopolymer of Marine bacteria Delaya Marina. S. Kagewade, G. C. Chen, C. R. Clayton, T. E. Ford and R. Mitchell Accepted for Pub in Corrosion (November edition) 1996

2. Non-Refereed Publications and Published Technical Reports

An XPS Study of Sulphate-Reducing Bacteria Influenced Corrosion
G. C. Chen, Ph.D. Thesis
Spring 1996 SUNY at Stony Brook
(Volume contains 3 unpublished papers)

3. Presentations
   a. Invited

Keynote Paper at 117th Meeting of Japanese Institute of Metals - Honolulu, 1995 Dec. 13-15, 1995; Modification of the Passive Film Formed on Stainless Steels by Bacterial Metabolic Products - C. R. Clayton

Keynote Paper to be presented at 7th European Conference on Applications of Surface and Interface Analysis Gothenburg, Sweden 16-20 June 1997: - Application of Surface Analysis to the Study of the Microbiological Corrosion of Stainless Steel. C. R. Clayton

   b. Contributed

The effect of Sulphate Reducing Bacteria on the Passive Films Formed on Austrenitic Stainless Steels, C. R. Clayton, G. Chan, G. French and R. Sadowsky. Fall meeting of Electrochemical Society, Chicago, Illinois Oct 1995

4. Books (and sections thereof)

None.

E. List of Honors/Awards

Name of Person Receiving Award	Recipient's Institution	Name, Sponsor and Purpose of Award
None		

F. Participant Status

Richard Sadowsky - MS 1996 (This contract.)
Status: Attended business school and received accelerated M.B.A. Resides in Colorado in private business.

G. C. Chen - Ph.D. 1996
Status: Post-doctoral fellow with Prof. D. C. White, University of Tennessee, Knoxville

Undergraduate

Elizabeth Lerum - B.S. student
Marvin Vasquez - B.S. student

Graduate Student

Manual Montserrat - M.S./Ph.D. student now funded by Army Research Laboratory Program.

G. Sponsored Research

(i) Investigation into the Attachment of Bacteria to Metal Surfaces
Sponsor: ONR IDN° N000149410823
C. R. Clayton charges zero time to contract.

(ii) Surface and Interface Characterization of Advanced Materials
Sponsor: John's Hopkins University IDN° 86096349
9/15/96 - 12/30/96 $51,450
Co P.I. Dr. G. P. Halada
C. R. Clayton charges zero time to contract

(iii) Mechanism of Al Alloy Corrosion and the Role of Chromate Inhibitors
Sponsor: AFOSR Contract Pending
1/9/96 - 31/08/2001 $765,000 (to SUNY)
Co-P.I. Dr. G. P. Halada
C. R. Clayton Charges 1 month to contract

(iv) Materials Research Science and Engineering Center: Center for Thermal Spray Research
Sponsor: NSF
9/1/96 - 12/31/2000 $3.74 Million
P.I. - H. Herman Multiple Co-P.I.'s
C. R. Clayton plans to charge 1 month to contract

(v) URI/RIP Non-destructive and New Contact Evaluation of Corrosion and Fatigue by Laser Speckle and Laser Moire
Sponsor: AFOSR IDN° F496 209 30218
2/1/93 - 12/31/96 Funding ?
C. R. Clayton charges zero time to this contract.

H. SUMMARY OF FY96
PUBLICATIONS/PATENTS/PRESENTATIONS/HONORS/PARTICIPANTS
(Number Only)

		ONR	non ONR
a.	Number of Papers Submitted to Referred Journal but not yet published:	2	3
b.	Number of Papers Published in Refereed Journals:	1*	2
c.	Number of Books or Chapters Submitted but not yet Published:	November 1996 0	1
d.	Number of Books or Chapters Published:	0	0
e.	Number of Printed Technical Reports & Non-Referred Papers:		
f.	Number of Patents Filed:	0	0
g.	Number of Patents Granted:	0	0
h.	Number of Invited Presentations at Workshops or Prof. Society Meetings:		2
i.	Number of Contributed Presentations at Workshops or Prof. Society Meetings:	3	5
j.	Honors/Awards/Prizes for Contract/Grant Employees: (selected list attached)	0	0
k.	Number of Graduate Students and Post-Docs Supported at least 25% this year on contract grant:	2 (+ 2 UGS)	1
	Grad Students: TOTAL	4	1
	(*1 Undergraduate 100% Summer) * Female	0	0
	**(1 Grad Student (summer) ** Minority (1 UG Student (summer)	1	0
	Post Doc: TOTAL		
	Female		
	Minority		

l. Number of Female or Minority PIs or CO-PIs

New Female		
Continuing Female		
New Minority		
Continuing Minority		

REPORT DOCUMENTATION PAGE

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13. ABSTRACT *(Maximum 200 words)*

The influence of sulfate-reducing bacteria (SRB) on the passivity of Mo-bearing (type 317L) and low Mo content (type 304) austenitic stainless steels (SS) was investigated by x-ray photoelectron spectroscopy (XPS), microbiological and electrochemical techniques. Samples were exposed to SRB, and then the resulting surfaces were analyzed by XPS, and the corrosion resistance by potentiodynamic polarization in deaerated 0.1 M HC1. In order to further understand their passivity, the SRB-exposed samples were also analyzed by XPS after potentiostatic polarization at a passive potential in the hydrochloric solution.

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